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May 15, 1975

TO: SUMEX-AIM Advisory Committee

FROM: Dr. Michael A. Arbib

SUBJECT: The Proposal by Professors Fishman and Riseman

Elliott Levinthal wrote to me suggesting that I send you all my response to a conversation that I had with Ed Feigenbaum concerning the proposal submitted to you by Drs. Fishman and Riseman. While he suggested that that response might take the form of a revised proposal, time limitations (I leave for a month in Israel in a couple of days) suggest that it would be better to simply respond to my notes on the questions that Ed raised.

1) The first concern was that there appeared to be some tokenism with respect to the application of A.I. to medicine, and that the Committee had been disturbed by the fact that I was not an investigator on the proposal. I gathered from this question that your Committee had not discussed the computer planning document of January 1975 which I presented to Drs. Feigenbaum, Lederberg, and Levinthal when I visited Stanford last January. The document makes quite clear, I believe, the intimate relationship between our work in artificial intelligence and our work in analyzing the brain here at the University of Massachusetts at Amherst. However, the reaction to this document was that it was too rich, and that your committee would need to look at one or two specific projects for possible inclusion on SUMEX-AIM, rather than having to respond to the computer planning document as a whole. Thus, it was suggested that the final proposal focus on those aspects of our work that seemed ready for network implementation. When I returned to Amherst, then, I went through the computer planning document with my colleagues, looking for those particular projects which were indeed ready for the network, and would benefit from the particular facilities that were available to it. Moreover, it had been impressed upon me that the explicit use of artificial intelligence techniques was mandatory.

As a result of these discussions, we focused on our work on the VISIONS system, on deductive systems, and on mechanized theory formation. As is clear from our computer planning document, the work on the VISIONS system already is closely coupled to our analysis of neural mechanisms of vision. The work on mechanized theory formation is intended to tie in with our project on the analysis of animal behavior and learning. Finally, it is expected that the work on deductive systems will provide a valuable tool for the VISIONS system project, and thus tie in at a secondary level to

the work of our brain research group. It is my hope that with the explicit relationships presented to you in our computer planning document, you will reverse your initial judgment that our interest in the application of A.I. to medicine is mere tokenism. On the other hand, you may also come to appreciate that those portions of our work which are more 'medical' are currently proceeding quite comfortably on our available computer systems. It does not seem worthwhile, then, to retool those projects for SUMEX-AIM <u>at this time</u>. However, it is our expectation that if the work on the VISIONS system is successful, then the relationship--for example--of the preprocessing strategies studied by Riseman with the preprocessing strategies studied by Spinelli will lead to extensive use of the SUMEX-AIM system by our neuro-physiologists. Again, if the work on mechanized theory formation becomes successfully established on SUMEX-AIM, then the tools which it provides will be used by Professor Kilmer in his work on animal learning.

Looking at things from the other point of view, we believe that eventually the CORETEX language would be an invaluable tool to make available on SUMEX-AIM. However, at the present exploratory stage, we find it more comfortable simply to work with the GT-44 in the Center for Systems Neuro-science. However, it is clear that once our colleagues are successfully established on the network, and once we have worked out the basic design characteristics for CORETEX, it will be very tempting indeed to carry out a full-scale implementation on the SUMEX-AIM system.

With these preliminary remarks to place the specific proposals in perspective, let me turn to the three components of the original proposal.

2) I gather that your group was favorably impressed with the VISIONS system, but was somewhat dubious about the lack of explicit medical application. As I have already mentioned, the computer planning document shows that the development of this system will greatly aid us in our analysis of the visual systems of vertebrate brains. However, it is perhaps also worth stressing that the general procedures that are being developed should prove of use to a large variety of biological applications. We have already invested so much time in the analysis of outdoor scenes that it does not seem appropriate to change course right now. But, because the VISIONS system involves the interface between semantic knowledge and the primitive visual features extracted from an image, it can be applied to the analysis of medical images such as X-rays or microscopic blood cell images. In these domains one often must deal with the complexities induced by heavily textured and 'noisy' scenes. The techniques for segmentation of natural scenes should be directly applicable to these images. In addition, the parallel processing structure being simulated will provide a design for very fast hardware whose construction, due to technological advances, is quickly becoming feasible. The semantic knowledge base that we are using can be substituted by diagnostic considerations for interpreting medical data. The VISIONS system also has the flexibility to incorporate such goal orientation at many levels of processing so that efficiency and focused attention can improve performance.

3) The response that I got about the work on deductive systems was "that the field had passed it by". Perhaps this is due to the false impression that the proposed work on deductive systems was merely another technique for resolution. Dr. Fishman has stressed that what he is doing is providing new strategies which go far beyond resolution—in fact, resolution becomes but one small part of the overall system. In view of this, he has been able to build a system which is both dramatically faster, and capable of handling a dramatically larger data base, than any resolution system. It is for this reason that we have used the terminology 'deductive system'. I have already mentioned that Dr. Fishman expects to use his techniques to help with the querying of the semantic data base for the VISIONS system. In addition, however, since he is genuinely concerned with the generality of his approach, he is keen to have access to a large medical data base. Thus, if he were to get on SUMEX-AIM, we would have a genuine opportunity to compare his deductive systems approaches to the other approaches currently in use on SUMEX-AIM. In any case, Dr. Fishman has put together a statement in support of research in deductive systems, and I append this to my letter.

4) The reaction to the work on mechanized theory formation was that it is premature, and that the baseball world seems somewhat inappropriate. The answer to the first question is that we are at the beginning of work on the Ph.D. thesis of Elliot Soloway, so that the proposal you received accurately reflected his state of development. However, it is our judgment that Mr. Soloway is an exceptionally qualified student, and we believe that his access to SUMEX-AIM will allow him to produce a highly significant piece of A.I. research. As I believe Chuck Schmidt will spell out in a letter to Dr. Levinthal, he and Mr. Soloway have been working closely together this year, and it is their hope that Soloway will be able to get on SUMEX-AIM so that they may continue their collaboration via the network. As far as the use of baseball is concerned, I imagine that it is no more nor less relevant to medical applications than Schmidt's area—what is shared is the attempt to build a useful approach to mechanized theory formation using a world that is simple enough to be amenable to treatment, and complex enough to offer interesting challenges. As such, the problems of baseball have become an integral part of Mr. Soloway's thinking. However, he is certainly not so far along that he would not listen carefully to any suggestions you might wish to make about a more useful model world—especially if you can give him access to an appropriate data base available on SUMEX. Our main reservation, however, is that it might distract dangerously from the development of Mr. Soloway's methodology if the world you are to suggest were to involve too much knowledge of some specialized area of chemistry or medicine, with the result that he would be required to spend a year acquiring a background knowledge in that field rather than proceeding directly with the development of his contributions to artificial intelligence. We expect that the methodology would eventually be very useful to the development of automated diagnosis. In any case, the system will provide new insight into the representation and manipulation of time sequences of interacting activity— a fundamental problem for biological organisms, and also of interest in trying to analyze disease processes. As I stressed in my introductory comments,
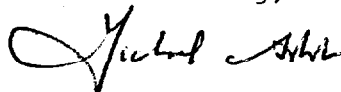
Soloway's work is heavily influenced by studies of mammalian behavior carried out by our brain group. In particular, mechanisms for focusing attention, semantic filtering, and exploring a domain of possibilities will prove very valuable. The baseball domain provides a constrained but very rich environment for the initial developement of these ideas.

It is my hope that this letter, together with its supporting documents, will make clear that the proposal you have received from Drs. Fishman and Riseman is not a mere collage of pure A.I. investigations, but is rather a sampling of a concerted effort at the interface between artificial intelligence and brain research—a sampling constrained by the question: "What projects are ready to go on the SUMEX-AIM network now?"

Since I shall be out of the country between now and your deliber-ations at Rutgers, it would probably be best if any further questions between now and then were delivered to Dr. Riseman in this department.

With many thanks for your consideration of our proposal,

Yours sincerely,

Michael A. Arbib
Professor and Chairman

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Appended: Computer Planning Document
           "In Support of Research in Deductive Systems"

cc: D. Fishman
    E. Riseman
    C. Schmidt
    E. Soloway